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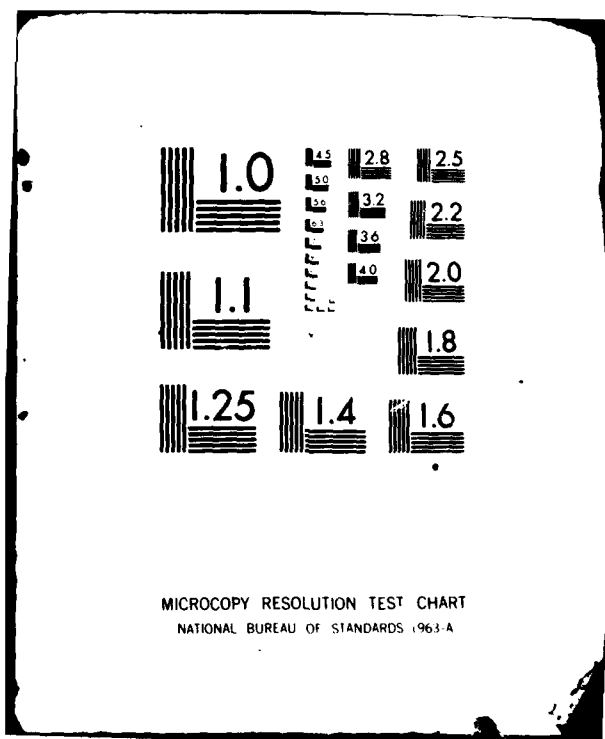
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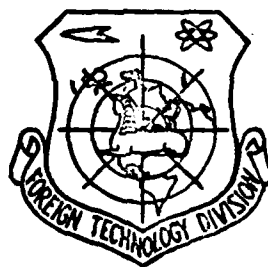
FOREIGN TECHNOLOGY DIVISION



BREEZES ON THE VOLGA NEAR SARATOV

by

V. Kellerman



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U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

Block	Italic	Transliteration	Block	Italic	Transliteration
А а	<i>А а</i>	A, a	Р р	<i>Р р</i>	R, r
Б б	<i>Б б</i>	B, b	С с	<i>С с</i>	S, s
В в	<i>В в</i>	V, v	Т т	<i>Т т</i>	T, t
Г г	<i>Г г</i>	G, g	У у	<i>У у</i>	U, u
Д д	<i>Д д</i>	D, d	Ф ф	<i>Ф ф</i>	F, f
Е е	<i>Е е</i>	Ye, ye; E, e*	Х х	<i>Х х</i>	Kh, kh
Ж ж	<i>Ж ж</i>	Zh, zh	Ц ц	<i>Ц ц</i>	Ts, ts
З э	<i>З э</i>	Z, z	Ч ч	<i>Ч ч</i>	Ch, ch
И и	<i>И и</i>	I, i	Ш ш	<i>Ш ш</i>	Sh, sh
Й й	<i>Й й</i>	Y, y	Щ щ	<i>Щ щ</i>	Shch, shch
К к	<i>К к</i>	K, k	Ъ ъ	<i>Ъ ъ</i>	"
Л л	<i>Л л</i>	L, l	Ы ы	<i>Ы ы</i>	Y, y
М м	<i>М м</i>	M, m	Ь ь	<i>Ь ь</i>	'
Н н	<i>Н н</i>	N, n	Э э	<i>Э э</i>	E, e
О о	<i>О о</i>	O, o	Ю ю	<i>Ю ю</i>	Yu, yu
П п	<i>П п</i>	P, p	Я я	<i>Я я</i>	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere.
When written as ё in Russian, transliterate as yë or ë.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	sinh ⁻¹
cos	cos	ch	cosh	arc ch	cosh ⁻¹
tg	tan	th	tanh	arc th	tanh ⁻¹
ctg	cot	cth	coth	arc cth	coth ⁻¹
sec	sec	sch	sech	arc sch	sech ⁻¹
cosec	csc	csch	csch	arc csch	csch ⁻¹

Russian English

rot	curl
lg	log

Breezes on the Volga Near Saratov

Breeze winds are usually encountered on the shores of seas, for example, on the shores of the Black and Caspian Seas and on the shores of large lakes, such as, Lake Ladoga and Lake Onega; in mountainous terrains - between the peaks and valleys - special local winds are observed, very similar to sea and land breezes, known by the name of mountain-valley breezes. On the Volga, where there is no large body of water and where it would appear there are insufficient conditions for the development of mountain-valley winds, the breeze is an extremely unexpected phenomenon.

However, a detailed analysis of the nature of local winds in accordance with the observations of the Saratov meteorological station reveals with sufficient clarity their breeze character.

Let us direct our attention to the observations of wind speed and direction in accordance with the Wild anemoscope, carried out at the Saratov experimental field station, on the right bank of the Volga, during the period 1912-1921, when this anemoscope was set up mostly openly:

Having selected from the synoptic charts those days, when the observed winds could be only winds of local origin, we obtained material, definitely indicating the breeze character of these winds.

Table 1 shows, which directions the selected winds were distinguished by, and how frequently they recurred.

Table 1.

The number of days during the year with wind (average for 1912-1921).

Направление 1	З	СЗ	З	СЗ	С	СЗ	СЗ	СЗ	СЗ	СЗ	СЗ	СЗ	СЗ	СЗ	СЗ	СЗ	СЗ
Днем 2	4,0	4,2	8,7	4,7	9,1	4,6	—	8,3	8,4	5,9	3,9	3,5	—	—	—	—	—
Ночью 3	—	—	—	—	—	—	—	—	—	—	—	—	14,1	2,6	8,9	1,4	—

KEY: 1 - Directions; 2 - During the day; 3 - During the night.

It is evident from the table, that the local winds possess a clearly expressed diurnal periodicity here with respect to direction: during the night they blow from the western points of the horizon, and during the day there are two separate flows, separated from each other by a south-eastern point, with respect to which we did not find one case of local wind. One of these flows, whose portion is 54% of the entire annual frequency of the daily local winds, we call the south-eastern flow, and the other with a frequency of 46%, we call the southern flow. This bifurcation of flow, as we shall subsequently see, is caused by the direction of the Volga riverbed.

Table 2.

Direction of the wind at night.

Пункт 1	Повторяемость 2 (в %)
Западный 3	62
Западно-северо-западный 4	10
Северо-западный 5	33
Северо-северо-западный 6	5

KEY: 1 - Point; 2 - Frequency (in %); 3 - North; 4 - West-north-west; 5 - North-west; 6 - North-north-west.

It is evident from table 2 and 3, that the main point (direction) at night is West, and during the day the North-eastern and the Eastern directions (points) predominate in the North-eastern flow, and in the South flow there predominate the South and South-western Points (directions).

Table 3.

Wind direction during the day.

Северо-восточный поток 1		Южный поток 2	
румб 3	повторяемость (в%) 4	румб 3	повторяемость (в%) 4
Северный 5	11	Юго-восточный 11	27
Северо-северо-восточный 6	12	Южный 12	28
Северо-восточный 7	25	Юго-юго-западный 13	20
Востоко-северо-восточный 8	13	Юго-западный 14	13
Восточный 9	26	Западо-юго-западный 15	12
Востоко-юго-восточный 10	13		
	100		100

KEY: 1 - North-east flow; 2 - South flow; 3 - point (direction); 4 - frequency (in %); 5 - North; 6 - North-north-east; 7 - North-east; 8 - East-north-east; 9 - East; 10 - East-south-east; 11 - South-east; 12 - South; 13 - South-south-west; 14 - South-west; 15 - West-south-west.

The diurnal periodicity of local wind direction is emphasized by the considerable decrease in their frequency in the morning, at about 7 o'clock. This attests to the attenuation towards morning of the greater part of the night winds and to the absence of day winds with a breeze character; the latter is explained by the relatively slightly heated terrestrial surface at this time of the day.

The cases, isolated by us, of local wind are characterized by the following average frequency during the year:

During the day.....65.3 days
 At night.....63.7 days
 at about 7 o'clock in the morning.....27.0 days

For evaluating the value of this frequency let us compare it with the annual frequency, already known to us, of the breeze winds, with the frequency of the breezes on the southern shore of the Crimea (Table 4).

Table 4.

The average frequency of breezes during the year.

Наименование станции	Днем	Ночью
1	2	3
Саратов 4	65,3	63,7
Сарыч 5	121,8	121,1
Ялта 6	194,1	190,3
Судак 7	181,6	189,6
Севастополь 8	143,3	115,3
Сакн 9	115,7	121,7

KEY: 1 - Station name; 2 - During the day; 3 - At night; 4 - Saratov; 5 - Sarych; 6 - Yalta; 7 - Sudak; 8 - Sevastopol'; 9 - Saki.

The table shows, that the frequency of these winds is almost 3 time less, that the frequency of breeze on the southern coast of the Crimea from Yalta to Sudak and 2 times less, than the frequency of breeze at Sarych, Sevastopol' and Saki.

Let us then examine the average monthly frequency, calculated by us during the indicated period of the observations, which represents the annual variation in the frequency of daytime and nighttime wind (Table 5).

In the table presented, in the best possible way, is justified the expectancy to encounter in this annual variation in wind the greatest frequency in summer, when the height of the sun above the horizon is greatest, and least - in winter, when this height is the least.

Table 5.

Average Monthly Frequency

Ветры 1	Месяцы 2											
	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I	II
Дневной 3	3,0	6,7	7,4	6,8	8,9	8,7	6,4	5,9	3,0	2,7	3,1	2,9
Ночной 4	2,8	6,4	6,3	6,5	8,3	8,9	5,5	6,5	3,4	3,3	2,7	3,1

KEY: 1 - Winds; 2 - Months; 3 - Daytime; 4 - Nighttime.

The maximum frequency - 8-9 days during a month - is in July and August, the minimum - 3 days per month - is in December and January.

The local winds, which are of interest to us, are observed during the course of the entire year and in a considerable quantity during the winter, in spite of the ice and snow covers on the Earth's surface. This depends, apparently, on the inclination of the surfaces to the sun's rays and on the difference in altitude, which causes the descent towards morning of the cold air masses downwards to the Volga, whence winds of the South-east or South direction occur during the day.

The cited annual variation in the frequency of these winds, which have the same diurnal periodicity in variation in speed and direction, as the breezes, completely coincides with the annual variation in the frequency of the breeze winds, which it is not difficult to see, if we compare them with the similar data of the Crimean stations on the Black Sea coast. In order to confirm this, let us present in table 6 average frequencies, calculated by seasons for the Saratov station and for certain Crimean stations.

Table 6.

Average Frequencies during the Day.

Наименование станции 1	Весна 2	Лето 3	Осень 4	Зима 5
Саратов 6	17,1	24,2	15,3	8,7
Сарыч 7	26,2	38,2	39,6	20,8
Ялта 8	47,2	57,0	49,3	40,6
Судак 9	53,6	60,8	48,8	26,4
Сакх 10	35,0	43,6	28,4	8,7

KEY: 1 - Station name; 2 - Spring; 3 - Summer; 4 - Autumn; 5 - Winter; 6 - Saratov; 7 - Sarych; 8 - Yalta; 9 - Sudak; 10 - Saki.

Thus, the variation in frequency at Saratov is the same, as on the Crimean coastal stations, and the difference consists only in the absolute values of the frequency of the phenomenon. In spring and summer the frequency in the local winds at Saratov is two and a half to three

times less, than at Sudak, and one and a half times less, than at Sarych, and in winter it is three times less, than at Sudak, and the same, as at Saki.

Let us now focus our attention on the local wind speed and, in order to obtain an idea of the value of this speed, let us calculate the speed of all the local winds, isolated by us, for two summer months with respect to the observations of an anemoscope at 1300 hours. The average calculated speed in this case turned out to be equal to

In July.....3.38 m/s

In August.....3.48 m/s

Average 3.43 m/s

Consequently, the speed at 1300 hours in the afternoon, i. e., at the times and the months of the greatest development of local wind, was the same as taht, observed at this time for breeze; in August in this case an even greater speed was obtained, than in July, which agrees with the intensity of the phenomenon with respect to the annual variation in frequency. In Table 7 we present the frequency of speeds for July and August, from the observations at 1300 hours during 1912-1918, 1920-1922.

Table 7.

Скорость 1	1	2	3	4	5	1-5
Число случаев 2	26	25	52	38	35	177

KEY: 1 - Speed; 2 - Number of cases

This table also shows, that the speed of 3 m/s is most frequently repeated during these months.

Comparisons of the direction of daytime and nighttime flow of these winds with the geographical conditions of the terrain emphasizes with the greatest clarity the nature and the breeze character of the winds, which are of interest to us.

In examining wind as a vector, let us calculate the resultant of all the winds, blowing at night, and of all the winds, blowing during the day, both for North-east flow, as well as for South flow. Table 8 gives the value (frequency) and the direction (angle) of these resultants for each season.

The calculated resultants are plotted on the map of the region (rayon) in question in Figure 1; isohypsies are drawn on it and the areas, occupied by forests, are indicated with special hatching.

Table 8.

Direction and Frequency of the Resultants

Сезон или полугодие ¹	Д н е м ²				Н о ч ь ³	
	Северо-восточ- ный поток ⁴		Южный поток ⁵			
	Направ- ление ⁶	Повто- ряем. ⁷	Направ- ление ⁶	Повто- ряем. ⁷	Направ- ление ⁶	Повто- ряем. ⁷
Весна ⁸	62°	8,0	167°	8,4	290°	5,9
Лето ⁹	57	10,9	197	9,7	294	11,4
Осень ¹⁰	58	8,3	186	4,8	280	4,9
Зима ¹¹	72	3,3	192	4,2	289	3,1
Теплое полугодие (весна и лето) ¹²	59	18,8	192	17,9	293	17,4
Холодное полугодие (осень и зима) ¹³	61	11,7	187	9,1	284	8,2

KEY: 1 - Season and half-year; 2 - During the day; 3 - During the night; 4 - North-east flow; 5 - South flow; 6 - Direction; 7 - Frequency; 8 - Spring; 9 - Summer; 10 - Autumn; 11 - Winter; 12 - The warm half-year (spring and summer); 13 - The cold half-year (autumn and winter).

The map shows, that at night the West winds blow from the elevations; located to the west of Saratov and rimmed with a isohypse at 250 m and higher, where during the nighttime hours the air temperature is lower, than at the lower sites, and where the cold air masses are brought down by this West flow.

During the day the North-east and the South flows are directed from the valley, along which the Volga riverbed is located and where there

are vast forest expanses in the low places.

Here the water surface and the vegetation cover create during the day a lower temperature, than on the slopes and on the peaks. This local circulation of air masses is, apparently, a mixed type of mountain-valley wind and breeze, arising between the dry land the the water surface.



KEY: 1 - Arbitrary symbols; 2 - valley; 3 - uplands; 4 - Saratov.

by V. Kellerman

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